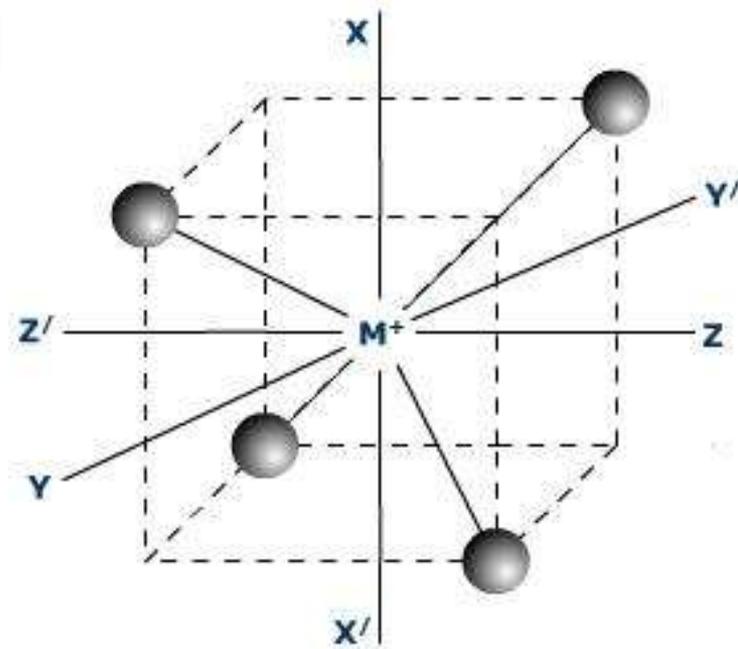
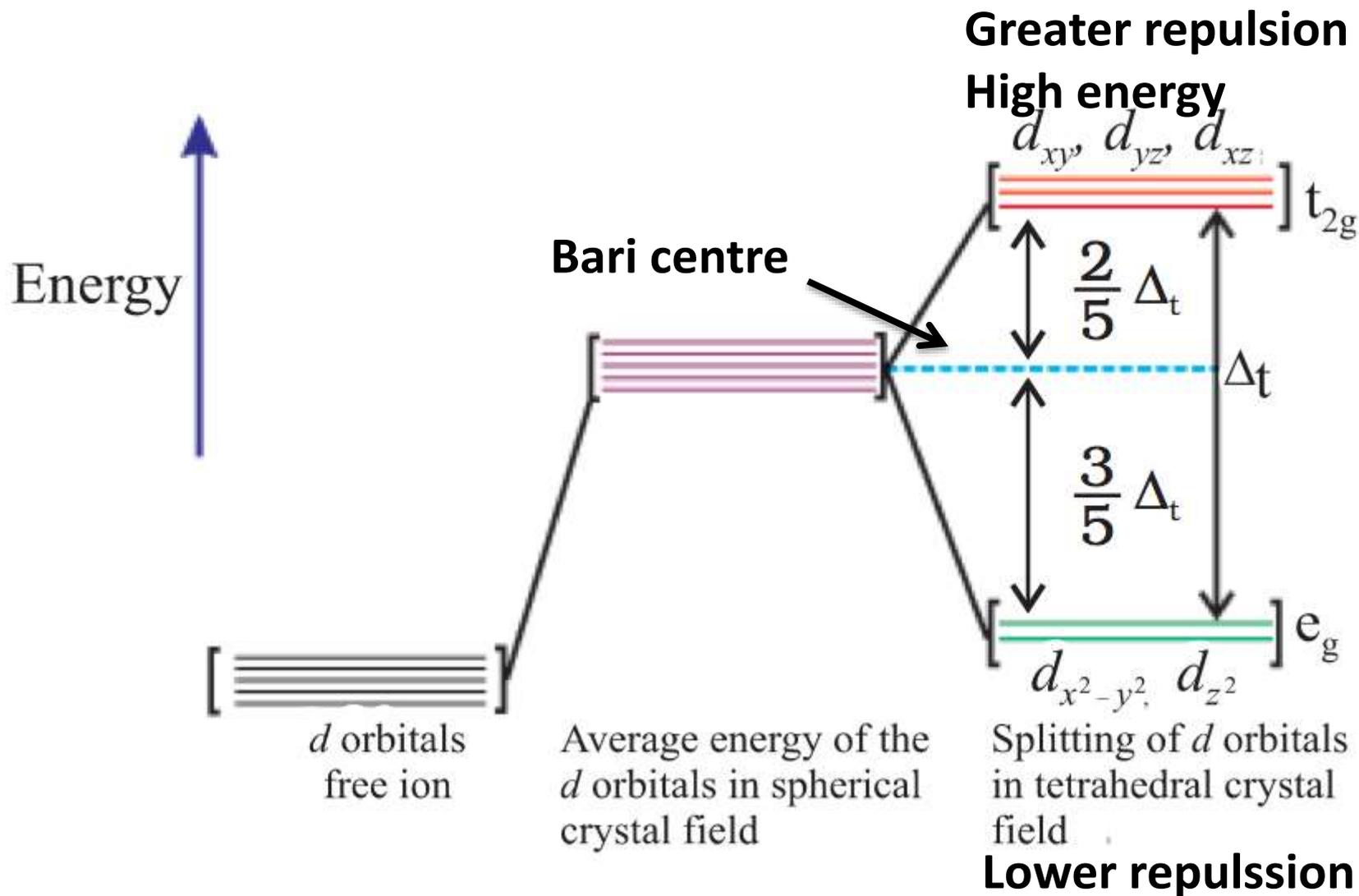


Application of CFT to tetrahedral complexes

- In the tetrahedral complex, $[MX_4]^n$, the metal atom or **ion is placed at** centre of the regular **tetrahedron** and the **4 ligands, are placed at four corners of the tetrahedron.**
- Ligand **approach the central Metal atom in between 3 coordinate x, y, z .**



In case of **strong field ligands**, the electrons **prefer to pair up** in eg orbital giving low spin complexes **while in case of weak field ligands**, the electrons **prefer to enter higher energy t_{2g} orbitals** giving more **unpaired electrons** and hence form high spin complexes.

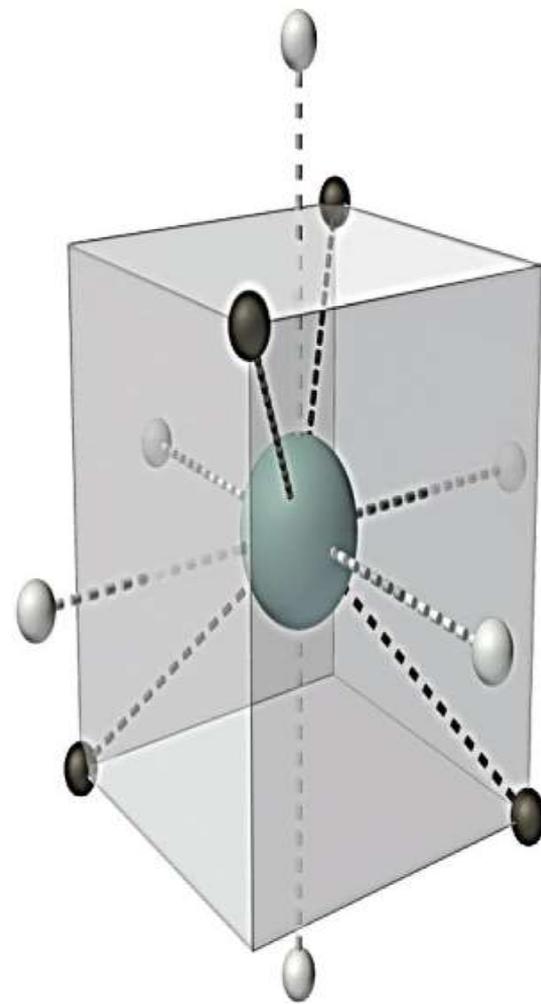


Application of Crystal field theory to octahedral complexes

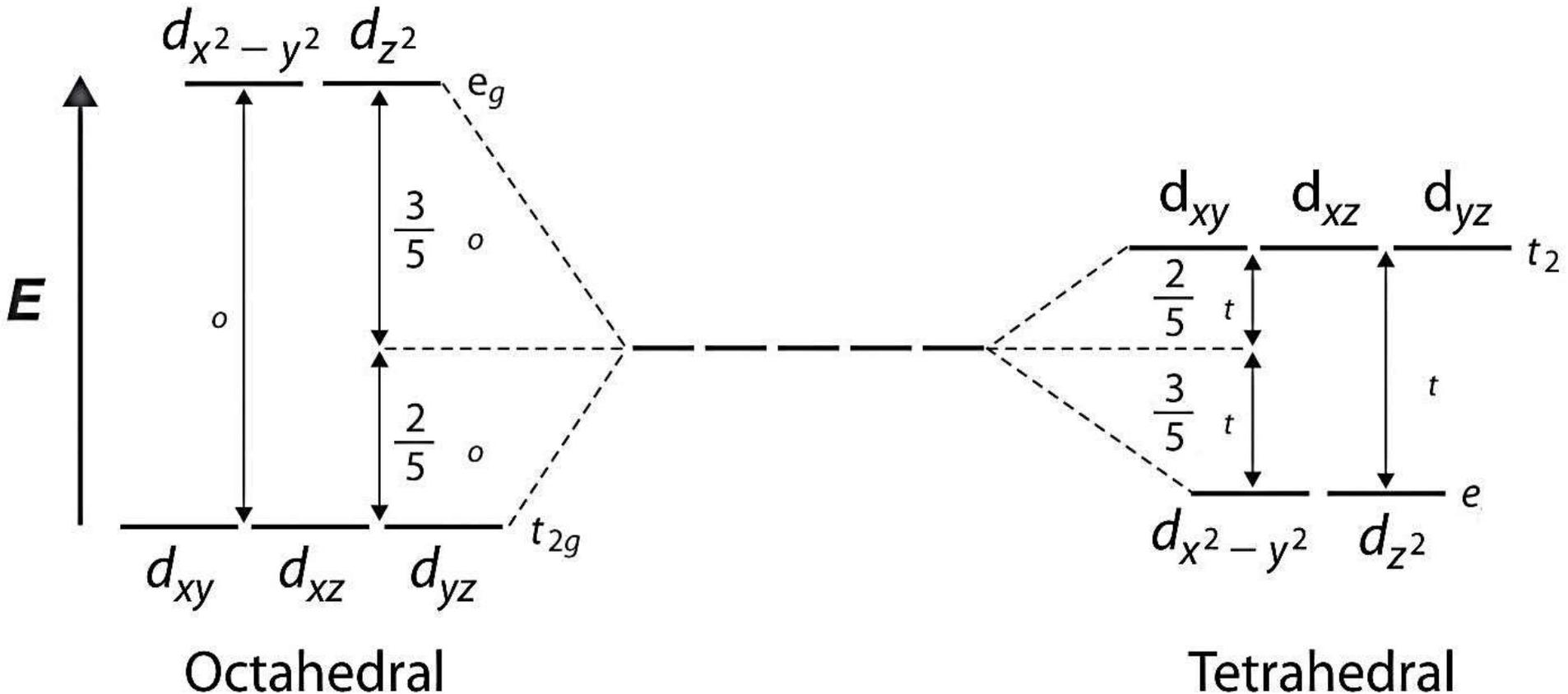
$[MX_6]^n$ the metal atom or ion is placed at the **centre** of regular **octahedron** while **6 ligands**

Occupy the **positions at 6 vertices** of the **octahedron**.

- Two orbital $d_{x^2-y^2}$ and d_{z^2} are **Axial greater repulsion** and d_{xy} , d_{yz} , d_{xz} **less repulsion**.



Five d orbital lose degeneracy and split into two point group. **The group t_{2g}** lower energy while **e_g** group have **higher energy**.



Application of Crystal field theory to octahedral complexes

- Experimental calculation show that the energy of t_{2g} orbital is lowered by $0.4\Delta_0$ or $4D_q$ and energy of e_g orbital is **increased** by $0.6\Delta_0$ or $6D_q$. Thus energy difference between t_{2g} and e_g orbitals is Δ_0 or $10D_q$ which is crystal field splitting energy.
- CFSE increases with the increasing strength of ligands and oxidation state of central metal ion.

Limitation of crystal field theory

- Does not explain the s and p orbital.
- Does not explain π bonding.
- Cannot explain partly covalent nature of the metal ligand bond.
- Spectrochemical series water is a stronger ligand than OH^- which is not explained satisfactorily.

Spectrochemical series

- The arrangement of various ligands in the decreasing order of their field strength and the splitting power of d-orbitals of the metal atom.
- Strong field ligand have higher splitting power of d orbital, hence higher crystal field splitting energy Δ_0 , while weak.....
- the field strength of ligand does not depend upon the geometry of the complex or nature of central metal atom or ionl

Spectrochemical series

- The decreasing order of field strength of some of the ligands is,

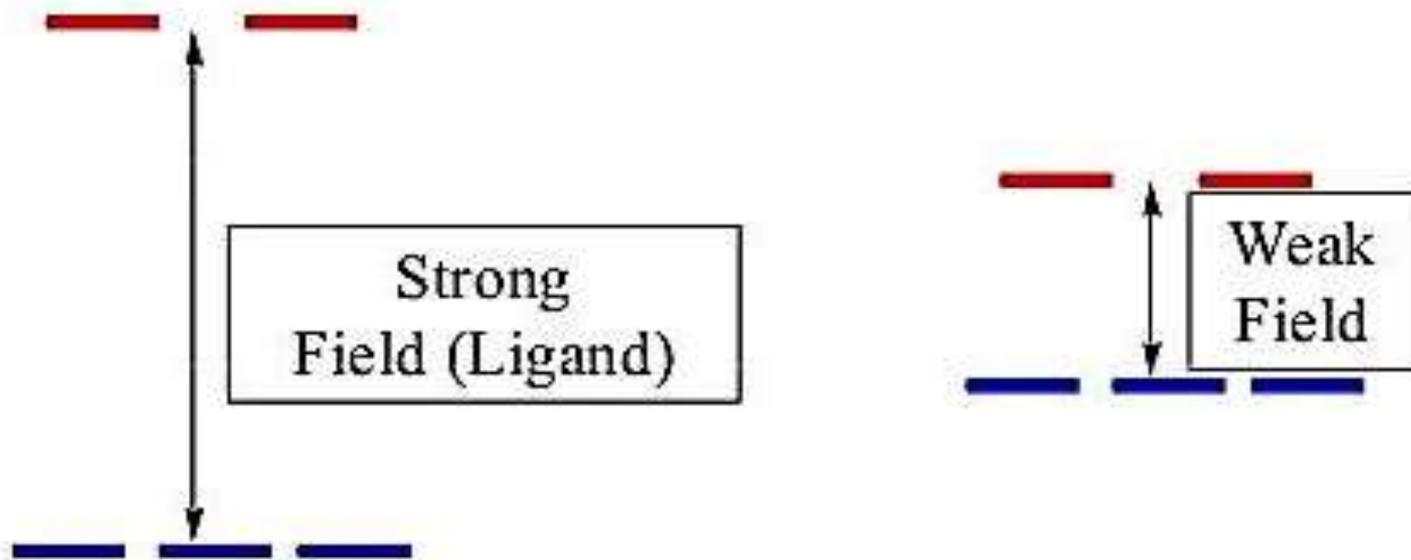


This series **depends on** the **power of splitting** the d orbitals and is called spectrochemical series.

Spectrochemical Series

An arrangement of ligands according to their ability to increase Δ for a given metal center

Weak – I⁻, Br⁻, SCN⁻, Cl⁻, N₃⁻, F⁻, H₂NC(O)NH₂, OH⁻, ox²⁻, O²⁻, H₂O, NCS⁻, py, NH₃, en, bpy, phen, NO₂⁻, CH₃⁻, C₆H₅⁻, CN⁻, CO – Strong



Colours in coordination compound

- Transition metal atoms (or) ions with one (or) more **unpaired electrons** and their complexes exhibit **colour** both in their solid and in **solution states**.
- If **absorption occurs** then the **transmitted light** bears a **colour complementary** to the **colour** of the light absorbed.

Coordination Entity	Wavelength of Light Absorbed (nm)	Colour of Light Absorbed	Colour of Coordination Entity
$[\text{CoCl}(\text{NH}_3)_5]^{2+}$	535	Yellow 	Violet 
$[\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+}$	500	Blue Green 	Red 
$[\text{Co}(\text{NH}_3)_6]^{3+}$	475	Blue 	Yellow Orange 
$[\text{Co}(\text{CN})_6]^{3-}$	310	Ultraviolet 	Pale Yellow 
$[\text{Cu}(\text{H}_2\text{O})_4]^{2+}$	600	Red 	Blue 
$[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$	498	Blue Green 	Purple 

Application of coordination compounds

1. **Extraction of metal:**
2. **Analytical chemistry:**
3. **Biological importance**
4. **In medicine**
5. **In electroplating**
6. **For estimation of hardness of water**
7. **In modifying the redox behavior of metal ions**

1. Extraction of metal:

- **Technique used for noble metal like Ag & Au.**
- Noble metals like **silver and gold are extracted** from their **ore by the formation of cyanide** complexes - **dicyanoargentite(I)** and **dicyanoaurate (I)**.
- $\text{Ag}_2\text{S} + 4\text{NaCN} \rightleftharpoons 2\text{Na}[\text{Ag}(\text{CN})_2] + \text{Na}_2\text{S}$
- $2\text{Na}[\text{Ag}(\text{CN})_2] + \text{Zn} \rightleftharpoons \text{Na}_2[\text{Zn}(\text{CN})_4] + 2\text{Ag}\downarrow$

2. Analytical chemistry:

- **Qualitative and quantitative** analysis.
- In the qualitative methods of analysis, complex formation is of immense importance in the **identification and separation of most inorganic ions**.

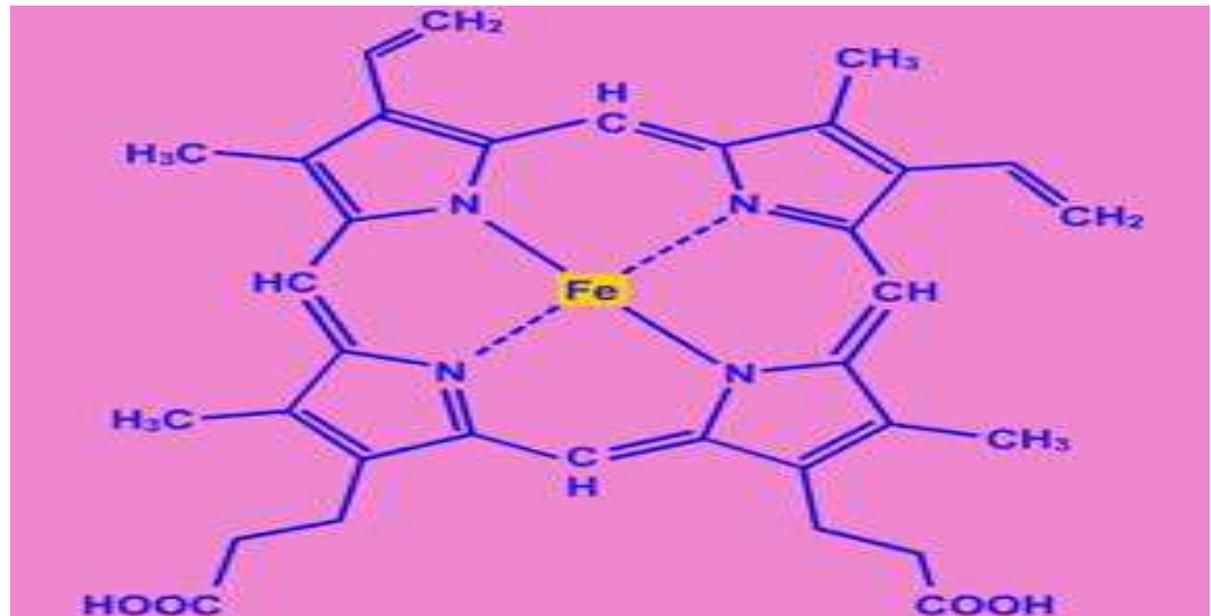


Since **Cu is more stable than Cd**. Therefore, on passing H_2S only **CdS** is **precipitated**. Thus Cd^{2+} ion easily detected in the presence of Cu^{2+} ions.

3. Biological Importance

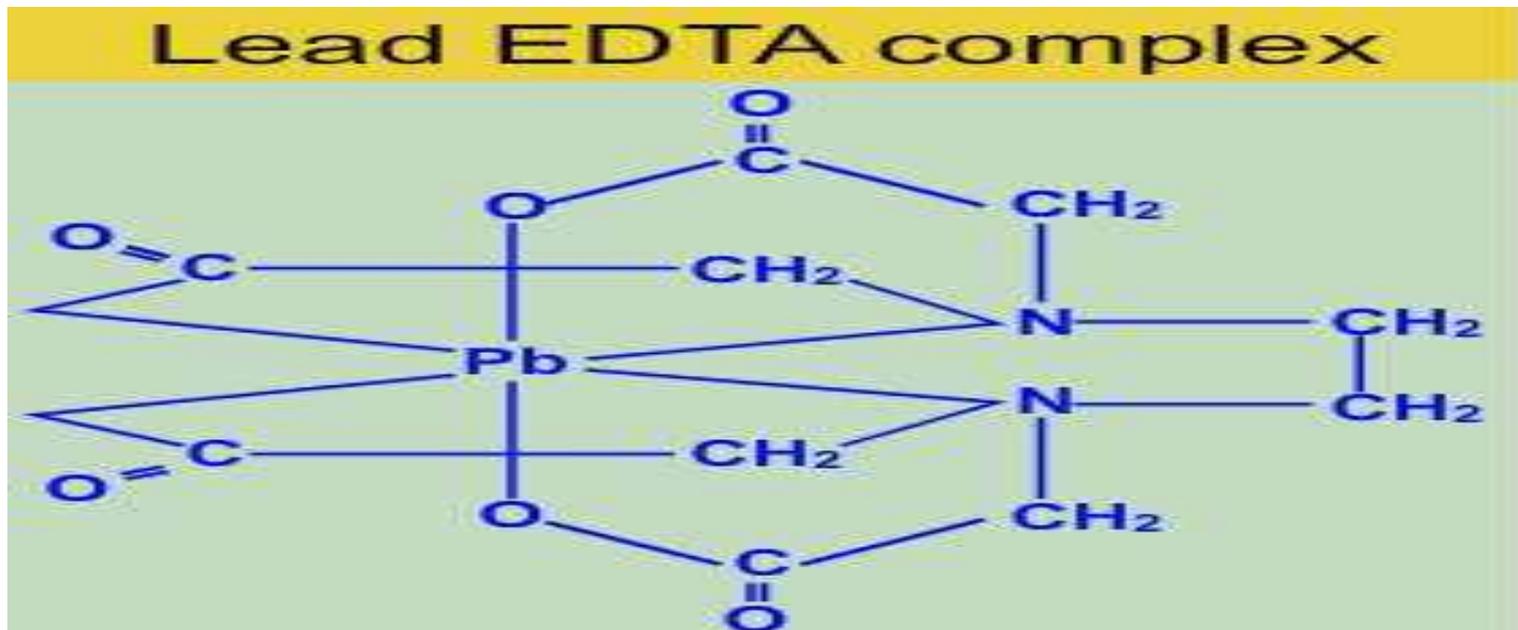
- Significant role in plant(chlorophyll-Mg) and animal Vitamin-B12.
- Haemoglobin, red pigment of blood that acts as the Oxygen carrier is a coordination

compound of iron



4. In medicine

- Treatment of **cancer** – **cisplatin**
- Platinum, cis $[\text{PtCl}_2(\text{NH}_3)_2]$
- **EDTA** is used to treat **lead poisoning**.



5. Hardness of water

- The hardness of water is **estimated by titration** with the sodium salt of EDTA. During titration, the **calcium and magnesium** ions in **hard water** form the **stable complexes**, Calcium EDTA and Magnesium EDTA. **Stability is different.**

